

# Special Report: The State of Homeland Security



Sandia's MicroChemLab™ systems are proving useful in fast, portable detection of harmful agents.

## *Sandia Leads in Chem/ Bio Protection*

The nation's preparedness for a terrorist attack or catastrophic accident involving chemical or biological (chem/bio) agents has been questioned many times in many arenas. So has our ability to prevent or respond to a terrorist attack by conventional explosives.

For nearly a decade, Sandia has been developing sensors, technologies and systems to help the nation rapidly detect dangerous materials, discover threatening activities or emerging epidemics, and mitigate the effects of any chem/bio attack. Working with other national laboratories, universities, government agencies, and commercial partners, San-

dia is helping the nation achieve a new level of preparedness.

We are moving rapidly toward applications that protect our major cities. Sandia-built chem/bio protection systems are now deployed in subways, airports, seaports, sports events, and at other large venues. Every part of Sandia contributes to this effort. Our nuclear weapons programs contribute much of the basic science and engineering, as well as rapid prototyping and advanced manufacturing. Many sensor programs came from our nonproliferation and assessments programs.

The MicroChemLab™ is one example of how many advanced technologies are developed into a system that will help

*“While observers are sharply divided over how much real progress is being made, the political will and technology now exists—and that’s a huge improvement.*

*On May 12, a simulated explosion in Seattle and the revelation of dangerous germ-warfare toxins in Chicago kicked off a \$16 million exercise to test America’s first responders and emergency personnel. Thousands of firefighters, police, hospital workers, and others from dozens of federal, state, and local agencies took part. Officials hope lessons learned from the event will help all levels of government better understand how to deflect a terrorist attack using weapons of mass destruction.”*

—Business Week,  
May 13, 2004

The MicroChemLab™ chem detector system identifies chemical warfare agents and toxic industrial chemicals.



protect the nation. Until recently, systems for gas-phase chemical analysis required racks of electronic equipment and a laboratory-scale chromatography instrument. Sandia developed a MicroChemLab™ to shrink this equipment to three microfabricated components: membrane preconcentrators, etched gas chromatography channels, and integrated surface acoustic wave modules. All the component parts and all of their linkages have been fabricated on a single monolithic silicon chip rather than of mixed and diverse materials, ensuring that standard microelectronic and micro-machining processes can be used.

Our derivative Chemical Warfare Agent detectors are working today under demanding real world circumstances at San Francisco International Airport. The MicroChemLab™ Bio Detector System has been used to identify biotoxins such as

ricin, staph B, and botulinum. It is now enabling identification of viruses and bacteria using protein signatures. We have demonstrated that the Bio Detector System can be used to acquire unique signatures from viruses, and we developed methods to ensure that these signatures are reproducible and robust.

Last year the Department of Homeland Security (DHS) initiated a project to create a broad-spectrum bioagent detector that is portable and easily concealed. In collaboration with Lawrence Livermore National Laboratory, the BioBriefcase detector will use the Sandia MicroChemLab™ platform with three analysis trains: DNA analysis to identify bacteria and viruses; immunoassays to identify bacteria, viruses, toxins; and protein signatures to identify toxins. The BioBriefcase will collect and detect samples in a stealthy and easily deployed manner, functioning as a portable laboratory, providing quick turn-around between sample analysis and responsive action.

### *Other advance in chem/bio detection*

Basic steps in the detection of natural or terrorist pathogens in water are fast and powerful separation and concentration steps. Sandia scientists have demonstrated a technique—insulator-based dielectrophoresis—that could replace lengthy centrifugation and filtration and can be automated, miniaturized, and scaled up. Using microchannels with etched insulators, the technique separates live from dead bacteria in less than one second, and also differentiates a number of bacteria species.

The AURA (Advanced UV Remote-Sensing Applications) ultraviolet laser-induced fluorescence LIDAR (Light Detection And Ranging) payload, miniaturized for deployment on an unmanned aerospace vehicle, has successfully detected a variety of biological warfare agent simulants. Sandia also developed a new ground-based system to provide advanced warning of

biological weapons threats and focused on both military and homeland security applications. The system automatically scans a 90-degree wedge of sky once every 30 seconds with ultraviolet laser pulses. Work continues on performance upgrades that support future military needs.

## Seaport and border security

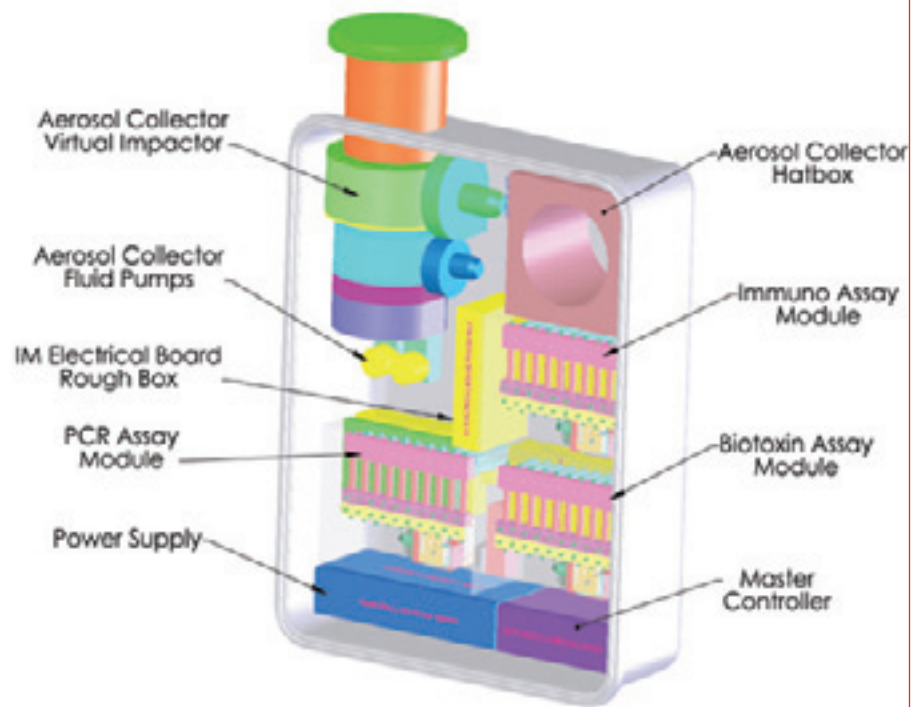
### ***Ships and ports are terrorism's new frontier***

*"It is one of the most heavily-guarded checkpoints on the border between Israel and the Gaza Strip. Security is so tight at Karni that goods are transferred from trucks parked back-to-back to prevent smuggling.*

*But despite those precautions, a truck carrying two suicide bombers left the border crossing into Israel at about 2 o'clock in the afternoon of March 14 headed for the deepwater port of Ashdod, about 40 kilometers south of Tel Aviv. By 3:30 pm, the truck had arrived at the port, one of Israel's busiest. About an hour later, the terrorists detonated their explosive devices, killing ten and wounding 18. A local police chief speculated that the real target may have been nearby chemical storage tanks, but that the bombs went off prematurely.*

*A subsequent investigation solved the mystery of how the terrorists eluded security forces: they had hidden themselves in a secret compartment of a steel shipping container.*

—MSNBC, June 21, 2004



Examples abound of the dangers of modern transnational terrorism and the contributions of Sandia expertise in diminishing or eliminating them. From brute force measures such as hefty concrete covers over nuclear material stores in Russia to sophisticated worldwide systems with vast arrays of sensors, Sandia has engineered first- and second-lines of defense. In response to new threats posed by potential terrorist actions against our seaports and border crossings, Sandia is again answering a new call for exceptional service.

Sandia is helping the nation's two largest ports develop the systems and technologies to better secure these vulnerable targets, while minimizing the economic impact on the global web of transportation.

Key modules of joint Sandia-Lawrence Livermore National Laboratory BioBriefcase Detector.





and Long Beach, U.S. Customs, U.S. Coast Guard, and Sandia) and numerous technology providers in the private sector.

Security is monitored from overseas points of origin to final U.S. destinations through the ports of Los Angeles or Long Beach. Sandia analyses support the identification of cost-effective means of addressing the most significant security problems of ports and their supply chains including terrorist attack, illegal immigration, drugs, and nuclear smuggling.

Sandia is deploying its Sensor for Measurement and Analysis of Radiation Transients (SMART) technology to help screen containers. SMART not only detects radiation, but identifies specific isotopes, a critical technological advance in efficiently determining threats. The SMART technology is now being deployed at land border crossings as well as at sensitive facilities.

### ***A miniSAR and other sensors***

In Afghanistan and Iraq, Sandia engineered and manufactured systems, such as synthetic aperture radars (SAR), provide extraordinary impact on the conduct of battle. Only a few SARs, deployed worldwide, can quickly and radically change the balance of field operations.

Development of SAR shows how Sandia's strengths are being applied to pressing military needs. SAR is a computed imaging technique, like medical tomography, relying on a "synthetic aperture" created by flying the small antenna above a target area. Sandia's SAR was originally seen as a day/night, all-weather imager. Sandia has made two significant enhancements



More than nine million shipping containers, and 95 percent of all freight from overseas, enter the nation through our 361 ports. The ports of Los Angeles and Long Beach account for 30 percent of the containers. The port of New York accounts for another ten percent. The top 30 ports account for all but 0.5 percent of containers. All ports are under the stresses of time and money to meet the requirements of the 2002 Maritime Transportation Security Act, which legislated measures to strengthen our defenses.

Sandia is the security consultant, systems integrator, and project manager for the Operation Safe Commerce (OSC)-Pacific program with the ports of Los Angeles and Long Beach. The OSC-Pacific program is an international partnership that involves the public sector (ports of Los Angeles

to the imaging capabilities of SAR—coherent change detection and interferometric terrain mapping—that demonstrate SAR offers much more than just imagery—information that could not be obtained otherwise.

Coherent change detection enables viewers to detect sub-millimeter changes in a landscape over a period of time. These subtle changes—for example, footprints across grass or leaves rustling in the breeze—could have startling military and nonproliferation applications. Once considered a mapping technology, Sandia has engineered SARs into event recorders.

Interferometric terrain mapping capabilities (IFSAR) enable large areas to be mapped at very high resolutions within a day, with the maps ready by the time the aircraft lands. In addition to providing new capabilities to military planners, SAR could help map—at a precision thousands of times greater than today's maps—vast areas of the Earth that are virtually uncharted today, with a clear benefit to civilian applications such as aviation, flood control, and agriculture.

Through breakthroughs in IFSAR design, Sandia has furthered the development of completely automated terrain-mapping systems. An aircraft-based system developed for the Army, known as Rapid Terrain Visualization (RTV), can map 30-square-nautical-miles per hour, providing height data every three meters with 0.8-meter relative height accuracy—more detailed and accurate than any previous real-time system.

RTV has proven valuable closer to home, too. Recently, data collected and processed by the system have been provided to the Albuquerque Mountain Rescue Council, a volunteer search and rescue group, for two recent missions in the Sandia mountains. The RTV maps used in both missions significantly enhanced on-the-spot knowledge of the terrain, thus helping to determine the safest, most efficient routes to the subject, demonstrating a real potential to help save lives.

Sandia's engineering excellence is now pushing SAR into new realms. Once installed in sizeable aircraft, now carried by drones, the microSAR of the future, using micro- and nanotechnologies, could be carried by very small aircraft or by micro-satellites. Sandia's SAR technology will be applied by General Atomics to a lighter, more reliable, and easier to maintain version of the Lynx radar system for the U.S. Army Communications Electronics Command. Lynx uses SAR to provide all-weather reconnaissance capabilities, including tracking ground-moving targets

Sandia's Rapid Terrain Visualization technology has aided members of the Albuquerque Mountain Rescue Council, like Bill Scherzinger, in two recent rescues.







A primary application for miniSAR will be aboard small unmanned aircraft like this one.

such as vehicles or human beings. According to General Atomics, the Lynx II version will deliver photographic-like images with 4-inch resolution at up to 19 miles away.

## Critical infrastructure Protection

### Great blackout of '03

*"The biggest blackout in US history left millions without power across a huge swath of the sweltering Northeast and southern Canada yesterday, jangling the nerves of many Americans who at first feared terrorists had struck again.*

*The outage stranded commuters in subway trains, triggered urban gridlock, shut down nuclear power plants, and forced powerless neighbors into city streets to gather around car radios for the news that this time it was simply a mammoth malfunction."*

—Boston Globe, August 15, 2003

The National Infrastructure Simulation and Analysis Center (NISAC) has become a key element in the national effort to protect critical infrastructures such as electrical power grids, natural gas and oil systems, and telecommunications. NISAC, a Sandia-Los Alamos partnership, was congressionally chartered and is being incorporated into the DHS. To identify and resolve critical vulnerabilities,

NISAC is developing models and simulations of critical infrastructures, their interdependencies, and the downstream consequences of attacks. Before and following the 9/11 terrorist attacks, Sandia conducted wide-ranging risk assessments on behalf of many national agencies. Sandia security experts have traveled the country developing and applying security assessment methodologies and other risk-management tools for the nation's dams and power systems, government buildings, chemical plants, water supplies, and other potential targets. For example:



A look at our power grid from space.

■ We assessed management systems and security practices of the U.S. Bureau of Reclamation, the nation's second largest producer of hydroelectric power. The analysis led to the integration of the latest supervisory-control and data-acquisition technologies at six hydroelectric projects, including Hoover, Shasta, and Grand Coulee dams. The program is now in its second phase, providing similar input for five additional dam sites. About

10 percent of America's electricity needs are provided by hydroelectric power.

- A classified assessment of nuclear power plant vulnerability was conducted in less than four months. The multilab team was engaged by the Nuclear Regulatory Commission (NRC) to carry out analyses to better understand the consequences of specific terrorist threats on nuclear plants. Two ongoing, plant-specific vulnerability assessments are refining insights gained in the initial study.
- For years Sandia has lent its systems analysis abilities to the national power grid. Labs' researchers in New Mexico and California study the security of communications between control systems, the distribution of power generating facilities and how it could be improved, and system vulnerabilities. Potential attacks on the system have long been recognized to have implications to the economy and national security.
- On request, Sandia assessed the potential impact terrorist attacks on numerous NNSA, DoD and NRC facilities. The assessment team was responsible for developing the methodology to quantify the structural response and consequence of any fires that might ensue. This endeavor brought to bear unique technical expertise, state-of-the-art computational tools, and experimental infrastructure to address a problem of national importance.
- A Sandia-Los Alamos team produced a state-of-the-art vulnerability assessment

of commercial aircraft attacks on two nuclear power plants for the NRC. The project analyzed the ability of aircraft to strike specific plant locations, resulting structural and fire damage, effects on critical safety systems and core melting, the resulting health consequences, and options to mitigate the damage.

The Information Operations Red Team and Assessments program performed numerous cyber system assessments, evaluations, and vulnerability experiments for a range of prototype-through-operational systems. Customers include civilian government agencies, the DoD, industry, and critical infrastructure assets including electricity, communications, water, oil, and gas.

Sandia researchers are developing information security practices to meet the next generation of Internet security threats. The research team developed Standard Agent Architecture II/Agent-in-a-box, which has brought revolutionary advances in agent and information security. The Advanced Information System Lab's intelligent agents provide a dynamic defense for domains, a significant contribution to national security that also represents substantial commercial value for the multibillion dollar cyber security industry.

Standards and controls are vital to the predictable and secure flow of electrical power. Our programs include technologies for automatically diverting or shutting down electricity flow from grid-connected systems when an electric distribution line shuts down—an important breakthrough that encourages distributed energy systems development.

